On-farm Composting of Livestock and Poultry Mortalities

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Introduction

Livestock and poultry producers in Ontario are recognized worldwide for their progressive approaches to animal husbandry. However, on-farm mortalities due to disease, accidental death and acts of nature are inevitable in the livestock production business.

The proper disposal of livestock mortalities is critical in preventing environmental contamination and the spread of disease. In Ontario, the *Dead Animal Disposal Act (DADA)* regulates the disposal of dead farm animals, specifically cattle, swine, sheep, goats and horses.

Under *DADA*, producers are required to properly dispose of on-farm mortalities in a safe and environmentally friendly manner within 48 hours of death. The act permits the following three disposal methods:

- Pick-up by a provincially licenced deadstock collector
- Burial under 0.6 m (2 ft.) of soil on farm
- Composting on farm

This factsheet provides an overview of composting on-farm mortalities and how you can apply composting to your own livestock operation. Although there are a number of composting system options, the information presented here is based on the popular composting bin unit, illustrated in Figure 1. Included are the basics of construction and guidelines for starting, managing and monitoring your composting unit.

Figure 1: A bin composting unit.

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The Composting Process

What is Composting?

Composting is a natural process by which micro-organisms, such as bacteria and fungi, break down organic material into a stable product called compost. This process is referred to as microbial activity. The composting process cannot be successful without a balanced integration of the following five elements:

- Carbon
- Nitrogen
- Oxygen
- Moisture
- Temperature

The product of the composting process is a stable, dark brown, soil-like material (humus) that can be applied to land.

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The Case for Composting

There are a number of advantages to adopting composting for disposal of on-farm mortalities, not the least of which are its practicality and environmental soundness. Here are some of the better known benefits of this disposal method:

Biosecurity

- Improves biosecurity and reduces health risks by eliminating the need for deadstock personnel and vehicles to visit the farm
- Significantly reduces the number of pathogens through the natural heating process

Cost Effectiveness

- Requires minimal to moderate start-up costs, depending on design and materials chosen
- Requires minimal operating costs, especially when using on-farm materials
- Provides a value-added soil amendment as an end product
- Eliminates processing and service fees associated with mortality collection

Practicality

- Offers an option for immediate disposal of livestock mortalities
- Accommodates animals of all sizes, as well as afterbirth
- Provides an alternative for disposing of mortalities that are not accepted for rendering
- Offers a disposal strategy to deal with an unexpectedly high number of mortalities
- Can generally be done year round

Environmental Soundness

- Provides a stable form of nitrogen and other nutrients
- Eliminates offensive odours and flies when units are well-managed
- Recycles on-farm materials

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Planning Your Composting Unit

You need to consider the following factors in the planning and design of your on-farm composting unit:

- Site selection
- Size of unit
- Construction

Siting the Composting Unit

Select a location that is out of view of your neighbours and the travelling public. Also make sure you know about and can comply with the environmental guidelines and regulations for your area by checking with the chief building official and by-law officer at your municipality.
To select an ideal site for your composting unit

- Choose a high, level, well-drained area away from wells, watercourses and tile drains. Choose a southern exposure where possible.
- Stay away from production units and wildlife habitat.
- Note any biosecurity risks (e.g., traffic patterns or vermin access) and make changes needed to reduce the risk of spreading disease.
- Allow space for handling mortalities, substrate and finished compost.
- Ensure easy access to manage and monitor the unit.
- Ensure convenient access to a water supply so that you can add water to composting bins as needed.

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Sizing the Composting Unit

The size of the composting unit will depend on the size and nature of your livestock operation and the projected annual number of mortalities.

Determining composting unit area

The total area needed for composting units on your farm will depend on the following:

- Number and size of bins needed for composting
- Number and size of bins, if needed, for storing carbon sources such as sawdust or straw (called substrate) and the finished compost
- Space needed for traffic flow and the operation of equipment

Determining number and size of bins

For each composting unit, plan for three composting bins. Two bins are needed for the primary stage of composting (first heat stage), and a third one is needed for the secondary stage of composting (second heat stage). Some larger livestock and poultry operations will require more than one composting unit. One or more bins may also be needed for storing substrate or finished compost, depending on your operation.

The size of bins required will depend on the weight of mortalities and the substrate used, so must be calculated for each individual operation. Consider the following when sizing bins:

Composting Bins

- Each primary composting bin needs at least 1.25 cubic metres for every kilogram (20 cubic feet per pound) of average daily mortality that will be composted if you use sawdust as a substrate. However, your composting bins should be one-and-a-half times this size to allow for an unexpected increase in mortality rate or expanded production. If you plan to use less dense substrates, such as straw and corn silage, you will need more bin space per kilogram (pound) of mortality.
  · Each secondary composting bin should be at least two-thirds the size of a primary bin (i e , at least .83 cubic metres for every kilogram (13 cubic feet per pound) of average daily mortality that will be composted). It may be practical to make the secondary bin the same size as a primary bin.

Storage Bins

- A storage bin for substrate should equal the volume of two primary bins, depending on your operation and supply of substrate.
- A storage bin for finished compost may be desirable. A bin equal in volume to one primary bin should be adequate for most operations.

Refer to Appendix 1 for a worksheet to help you determine the number and size of composting bins needed for your operation.

Constructing the Composting Unit

A number of structures lend themselves to efficient on-farm composting, including newly built, stand-alone units and add-ons to existing buildings. Even cattle and machine sheds may be adapted for composting. Composting units may be subject to municipal by-laws or other government standards. Check with the by-law officer and chief building official at your municipality, and ensure you can comply with all laws and guidelines before beginning construction.

Base

The base of the unit should be constructed to prevent leachate (liquid from the pile) and run-off from affecting the environment (see Figure 2). A well-constructed concrete pad effectively reduces environmental impact and provides a solid base for operating loaders and equipment without disturbing sub-soils. A clay soil (at least 1 m (3.3 ft.) of soil containing 20 per cent clay) is also an acceptable base.

Figure 2: A composting unit with a reinforced floor

Walls

Walls should be 1.4 to 1.8 m (4 to 6 ft.) high and be constructed to reduce leachate permeation. They should also be designed to keep out all animals, including vermin, and to withstand the demands of turning the composting piles with large equipment and loaders. Recommended wall materials include concrete, untreated wood and large tightly packed bales of hay or straw. Pressure treated wood is not recommended because of the possibility of heavy metal contamination of the compost. Figure 3 shows a compost unit built of large square bales.

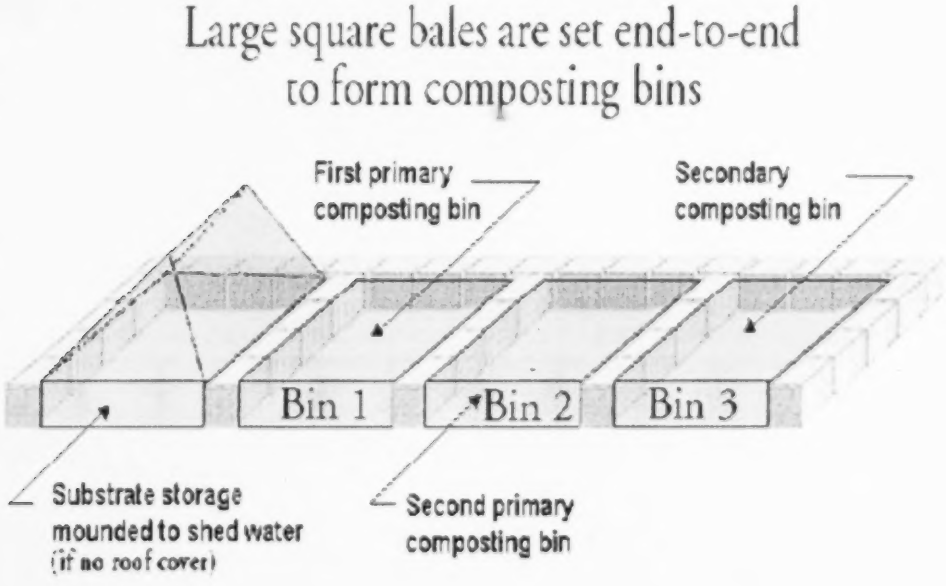
Large square bales are set end-to-end
to form composting bins
First primary composting bin
Secondary composting bin
Bin 1
Bin 2
Bin 3
Substrate storage mounded to shed water (if no roof cover)
Second primary composting bin

Figure 3: A simple large bale composting unit

Build three-sided bins that allow accessibility for the type of operating equipment you will use. The opening should be at least 0.6 m (2 ft.) wider than the loader or turning equipment being used. It is generally not advisable to construct a bin less than 1.8 m (6 ft.) wide. Installing a gate at the open end of each bin will help to discourage animals from scavenging.

Square bins with a floor area larger than 6 m^2 (64 ft. ^{2}) may require a forced aeration system to reduce the potential for spontaneous combustion due to lack of airflow in the middle of the pile. If the floor area needed for your operation exceeds that, consider building rectangular bins no wider than 2.45 m (8 ft.) or build more than one unit.

Roof

Having a roof or cover, as shown in Figure 4, will help to control moisture levels by protecting the composting pile from rain and snow. Excessive moisture increases the risk of leachate and runoff, and interferes with the composting process, thereby increasing the risk of odour.

Figure 4: A covered compost unit (photo courtesy of Minnesota Department of Agriculture)

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Getting Ready to Compost

To make composting work, you need to create and maintain the ideal environment for the micro-organisms to function in your pile. There are four essential components you must provide to accomplish this.

1. Carbon and Nitrogen

The carbon to nitrogen ratio (C:N ratio) in composting is critical for providing the required environment for the micro-organisms. To facilitate the composting process, you will need to add a substrate that is high in carbon to balance the high levels of nitrogen contained in the mortalities. Too low a C:N ratio may cause odours. Too high a C:N ratio may limit microbial activity, resulting in lowered temperatures and slowed decomposition. A C:N ratio ranging from 25:1 to 35:1 is recommended.

2. Oxygen

   Oxygen must be available in the pile to support necessary microbial activity. The substrate you use in the pile must create the space that traps air. The type and size of the substrate particles will affect air space. The substrate also provides insulation for the pile and absorbs liquid produced by decomposing mortalities.

3. Moisture

   An adequate moisture level is also needed to ensure proper microbial activity in the compost pile. The ideal moisture content is 45 per cent, but levels from 40 to 60 per cent are acceptable. Low moisture levels can reduce microbial action while high moisture levels inhibit the flow of oxygen and can lead to odour. The presence or absence of a roof, weather conditions, substrate type, animal species, and the number and size of the mortalities in the composting bin can each influence moisture levels.

4. Temperature

   Heat is the result of the composting process and is necessary for composting to work. To a certain extent, the more heat there is, the more heat is produced, and the faster composting proceeds. For proper composting, the temperature must reach at least 55°C (131°F) and remain there for several days or weeks, depending on the size of the mortalities. Lower temperatures will slow the micro-organisms, resulting in slower decomposition and less effective reduction of pathogen numbers. Temperatures higher than 71°C (160°F) will destroy the micro-organisms needed for composting.

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Choosing Your Substrate

You can source substrate material on-farm or off-farm. Cost, availability, and physical characteristics are important factors to consider. Clean sawdust has proven to be an excellent substrate for composting mortalities, although other materials with high carbon content such as straw, corn cobs, and corn silage may be used.

- Consider your options for on-farm or low cost substrates, such as straw, sawdust or wood shavings. If using an off-farm substrate, care must be taken to ensure that it does not contain foreign material such as metal or glass or chemical contamination. When ordering substrate for pick up or delivery, verify the origin and quality of the material and any related environmental regulations that may apply.
- Estimate the annual amount of substrate you will likely need, based on your annual mortality rate and the substrate available, and make sure you can access adequate quantities of substrate throughout the year.
- Ensure substrate particles are large enough to ensure adequate airflow but small enough to decompose or work effectively in the composting process. If necessary, chop substrate so particle length ranges from 3 mm to 13 mm (1/8 to 1/2 in.).
- Use finished compost as a "starter" for up to half of the weight of needed substrate, as an option.

How Much Substrate?

The size, number and species of mortalities will determine the amount of substrate needed for the process. Generally, a weight to weight ratio of 1.5 sawdust to 1 of mortality (i.e., 1.5 kg:1 kg or 1.5 lb.:1 lb.) is needed to balance the nitrogen in mortalities. This is approximately 1:1 on a volume to volume

basis. More substrate relative to mortalities will be required if you use a substrate with a lower C:N ratio.

Table 1: C:N ratio of some common organic materials (On-Farm Composting Handbook, 1992)

High Carbon Sources		Low Carbon Sources	
Material	**C:N**	**Material**	**C:N**
Corn stalks	70:1	Animal carcasses	4:1
Corn silage	38 - 43:1	Sheep, cattle and swine manure	15 - 20:1
Corn cobs	60 - 120:1	Poultry manure	6:1
Sawdust/Wood shavings	200 - 500:1	Horse manure	30:1
Straw	80 - 120:1	Fresh hay or grass	15:1

Equipment and Supplies

Loading and Moving Equipment

Equipment will be needed to move substrate and mortalities, and to move composting material from a primary to a secondary bin. Although a tractor-mounted, front-end loader is commonly used, no specialized equipment is required. To determine what is appropriate for your situation, consider the equipment available on-farm, frequency of usage, amount of material being handled, size and location of the composting system and available labour.

Thermometer

Use a thermometer to measure the temperature of composting piles. A thermometer constructed of stainless steel with a shaft of 6 mm (1/4 in.) diameter and measuring at least 1 m (3 ft.) in length is recommended. Thermometers may be available at farm supply stores.

Moisture Meter

A moisture meter (e.g., a hay moisture probe) is needed to measure the moisture level of composting piles. Use a meter that can accurately measure moisture levels from 30 to 70 per cent. Moisture meters may be available at farm supply stores.

Screen

If you will be composting mortalities that weigh more than 200 kg (440 lb.), a screen 13 mm to 25 mm (½ to 1 in.) will be needed to remove bone fragments prior to applying the compost to land. Screens may be available at farm supply stores.

Recording System

A record-keeping system is critical to your composting success. A simple system would allow you to record dates, details about mortalities added to a pile, substrate used, pile temperature, pile moisture and general observations (e.g., condition of top substrate layer, amount of leachate, odours, evidence of scavenging, and actions taken to correct problems). Create one that best suits your needs. Refer to Appendix 2 for an example of a simple record-keeping system.

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The Mechanics of Composting

A complete composting cycle has three main stages: bin filling, the primary heating stage and the secondary heating stage. Successful composting requires management and monitoring throughout this cycle.

Primary Bins-Filling and First Heat Stage

- Fill one of the primary bins over a period of 45 to 90 days, depending on the average weight of the mortalities.
- Leave the material in this primary bin to compost for an additional 45 to 90 days. The pile should heat to temperatures ranging from 55°C (131°F) to 65°C (149°F). In general, the pile temperature should remain within this range for at least 7 days to ensure that composting at this stage is effective. While one primary bin is composting, you would be filling another primary bin.
- Move the pile from the primary bin to the secondary bin after the first heat stage has occurred. By now, the temperature should have dropped to below 48°C (120°F).

Secondary Bin-Second Heat Stage

- Ensure mortalities protruding from the newly made pile are covered with at least 0.6m (2 ft.) of substrate.
- Leave the partially composted material in the secondary bin for the second heat stage. The pile again needs to heat to temperatures ranging from 55°C (131°F) to 65°C (149°F) and remain within this range for at least 7 days to ensure the composting is effective. In this heat cycle, the pile will reach the same high temperature observed during the first heat stage, but it may not remain high for as long. The main composting process is complete after the second heat stage has occurred and the temperature has dropped to below 48°C (120°F).
- Screen the composted material if visible bones remain in the material, e.g., from mortalities weighing more than 200 kg (440 lb.). Return any larger remaining bones back to a primary bin for further decomposition.

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Managing the Process

Timing and Flow

Each of the filling, primary heating and secondary heating stages takes about the same length of time. While the principles of composting are the same for both small and large animals, the size of mortalities and the substrate used will influence the time needed for decomposition. Typically, mortalities under 25 kg (55 lb.) take 45 days for each stage, for a total of 135 days for the complete cycle. For mortalities 25 kg and over (55 lb. and over) each stage takes 90 days, for a total of 270 days. However, it may take a year to completely compost mortalities over 200 kg (440 lb.).

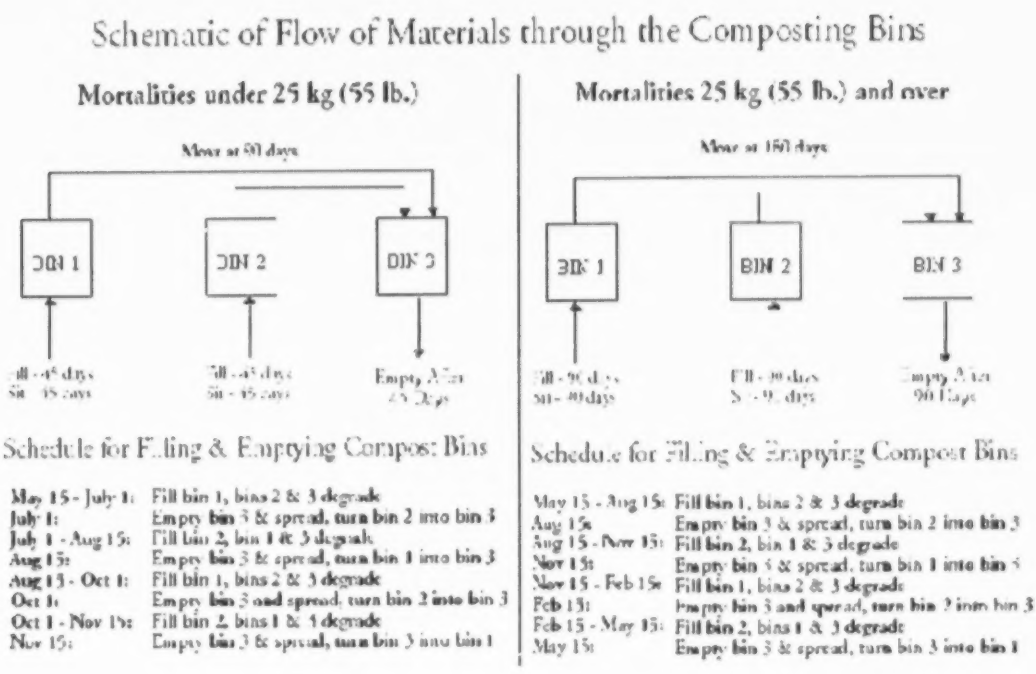
Schematic of Flow of Materials through the Composting Bins
Mortalities under 25 kg (55 lb.)
Mortalities 25 kg (55 lb.) and over
BIN 1
BIN 2
BIN 3
Schedule for Filling & Emptying Compost Bins
May 15 - July 1: Fill bin 1, bins 2 & 3 degrade
July 1: Empty bin 3 & spread, turn bin 2 into bin 3
July 1 - Aug 15: Fill bin 2, bin 1 & 3 degrade
Aug 15: Empty bin 3 & spread, turn bin 1 into bin 3
Aug 15 - Oct 1: Fill bin 1, bins 2 & 3 degrade
Oct 1: Empty bin 3 and spread, turn bin 2 into bin 3
Oct 1 - Nov 15: Fill bin 2, bins 1 & 3 degrade
Nov 15: Empty bin 3 & spread, turn bin 3 into bin 1
Schedule for Filling & Emptying Compost Bins
May 15 - Aug 15: Fill bin 1, bins 2 & 3 degrade
Aug 15: Empty bin 3 & spread, turn bin 2 into bin 3
Aug 15 - Nov 15: Fill bin 2, bin 1 & 3 degrade
Nov 15: Empty bin 3 & spread, turn bin 1 into bin 3
Nov 15 - Feb 15: Fill bin 1, bins 2 & 3 degrade
Feb 15: Empty bin 3 and spread, turn bin 2 into bin 3
Feb 15 - May 15: Fill bin 2, bins 1 & 3 degrade
May 15: Empty bin 3 & spread, turn bin 3 into bin 1

Figure 5. A schematic of the composting process

Once the first primary bin in your composting unit is filled and left to sit, the second primary bin can be filled while the first is heating. When the first primary bin is ready to turn into the secondary bin, the other primary bin is ready to sit. Figure 5 shows the movement of material between bins during the compost cycle.

Winter Composting Issues

As the temperature drops, it is more difficult to establish microbial activity in a composting pile. Avoid initiating a new pile from December to February. If a new pile must be started during the winter, be sure to use finished compost for up to half of the substrate. If a mortality is frozen, it should be thawed before being added to the pile.

Building the Pile

Make sure you review and comply with any provincial and municipal regulations and standards that govern composting on-farm mortalities before you start to compost, as these may be up-dated from time to time. Contact the Ontario Ministry of Agriculture and Food and your municipal by-law officer to verify the regulations and standards affecting on-farm composting.

1. Base

- Spread 0.6 (2 ft.) of substrate on the floor of a primary bin in your composting unit.
- Moisten as needed for substrate moisture level to reach 40 to 45 percent.

2. Mortality Layer

- Ensure that your veterinarian has examined animals that were euthanized or died on-farm of an unknown cause, to ensure they did not have a serious disease.
- Place the mortalities on the substrate at least 0.3 m (1 ft.) from the exterior edge of the bin.
- Space the mortalities evenly on the substrate, ensuring they do not touch each other.

- Cut the ligaments and tendons on the legs and fold them down to maintain the recommended pile height of less than 1.8 m (6 ft.). Placing a larger mortality on its back and opening the body cavity reduces bloating and promotes increased microbial activity.

3. Top Layer of Substrate

- Moisten substrate as needed for substrate moisture level to measure from 40 to 60 per cent.
- Immediately cover the mortalities with at least 0.6 m (2 ft.) of substrate.
- Ensure all parts of the mortalities are covered with substrate and the pile shape is appropriate for your situation (see below for information about pile shape).

4. Adding More Mortalities

- Skim off a portion of the top layer of substrate leaving at least 0.2 m to 0.3 m (8 in. to 12 in.) of substrate on top of the old mortalities.

Add new mortalities to the pile following steps 2 to 3 above.

Size and Shape of the Pile

Ensure the composting pile is 1.2 to 1.8 m (4 to 6 ft.) high. Piles less than 1.2 m (4 ft.) high generate insufficient heat, especially in colder weather, and there may not be sufficient substrate to maintain microbial activity for adequate decomposition. Piles higher than 1.8 m (6 ft.) may become compacted and not permit enough airflow for proper composting, possibly resulting in spontaneous combustion.

The shape of a pile will affect how moisture will filter into the pile. For a pile with a roof or cover, the top layer of substrate may be left flat or concave so that any added moisture will be easily absorbed. However, a convex or peaked shape may be appropriate for an uncovered pile to limit the amount of rain or snow that will filter into the pile. Note that although a peak may be desirable during a wet period, the pile may need to be flattened or dipped to hold moisture during a dry period.

Substrate cover

Make sure all mortalities are completely covered with 0.6 m (2 ft.) of substrate. Factors such as settling of the pile or wind may reduce the depth of substrate covering the mortalities.

Temperature

Take the internal temperature of the pile at several locations, including close to the last mortality added. Temperatures should increase and need to remain between 55°C (131°F) and 65°C (149°F) for at least seven consecutive days in the primary bin. In the secondary bin, temperatures will reach the same level but will not stay high for as long. If temperatures fall below 48°C (120°F), the composting process is becoming non-active; temperatures higher than 71°C (160°F) will destroy the composting micro-organisms and may lead to a fire in the pile. Refer to troubleshooting guide in Appendix 3 to address temperature problems.

Uncovered Composting Units

In the absence of a roof or cover, the shape of the compost pile will greatly influence its moisture level. A concave or dipped shape pile will retain moisture from rain and snow. By creating a peaked shaped pile, moisture will generally run off the sides, with less absorbed into the pile.

Moisture

Check the moisture content of the pile frequently to ensure it remains between 40 and 60 per cent. You may need to change the shape of the pile and adjust moisture content. Refer to troubleshooting guide in

Appendix 3 if problems with moisture levels occur.

Record Activity and Results

Set up a system to record the following:

- Temperature
- Moisture
- Mortalities (date added, number, species and weight)
- Substrate (amount and type used)
- General observations about the composting process, as well as problems and corrective actions taken

Refer to Appendix 2 for an example of a simple system for recording composting information.

Finished Compost

Properly finished compost has a slight earthy odour and resembles humus, or potting soil, in colour and texture, as shown in Figure 6. Ensure that visible bones remaining after the secondary heating are screened out and returned to the primary bin being filled. Once you ensure larger bones are removed, the compost is ready for on-farm land application.

Be sure to get a nutrient analysis of the finished compost to accurately determine nutrient content, and include it in your nutrient management plan or strategy. Table 2 shows the nutrient content of finished compost from a research project on composting swine mortalities.

Figure 6: Finished compost.

Table 2: Nutrient content of composted swine mortalities with various substrates

Analyte	Substrate	
	Sawdust	Straw
Dry Matter (%)	53.50	55.70
Crude Protein (%)	12.40	18.60

Crude Fat (%)	14.00	28.70
Calcium (%)	0.35	0.51
Phosphorus (%)	0.16	0.32
Potassium (%)	0.22	0.78
Magnesium (%)	0.04	0.10
Sodium (%)	0.21	0.31
Cooper (ppm*)	5.37	2.90
Zinc (ppm*)	48.80	25.40
Ash (%)	1.94	5.79
Carbon (%)	53.10	50.10
Nitrogen (%)	1.98	2.97
C:N Ratio	42.70	24.80

* ppm - parts per million

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Appendix 1: Worksheet for Sizing Mortality Composting Units

A. Determine the annual weight of mortalities on your farm

Steps	Sample Farm	Your Farm
1. Enter the number of mortalities per year	**60** mortalties/year	_____mortalities/year
2. Enter the average weight of the mortalities (refer to table at end of this section for	**125** kg/mortality	_____kg/mortality

weights).		
3. Calculate the total weight of annual mortalities for disposal: multiply the number of mortalities (line 1) by the average weight (line 2)	60 x 125 = **7500 kg/year**	_____ x _____ = _____ kg/year

B. Determine the volume needed for the composting unit consisting of at least two primary bins and one secondary bin, and the number of units required.

Steps	Sample Farm	Your Farm
4. Calculate volume of one primary bin: multiply the total weight of annual mortalities (line 3) by a conversion factor to account for mortality size (under 25 kg or 25 kg and over) and substrate density. Use conversion factor from Table 3 on next page. (Note: conversion factor includes allowance for expansion or unexpected mortalities.)	The conversion factor adjusts for mortality size and substrate used. See Table 3 for conversion factors. Example is based on mortalities 25 kg and over, using sawdust as a substrate. 7500 kg/year ÷ **703** = 10.7m^3	_____ ÷ Conversion Factor = _____ m^3
5. Calculate the volume of one secondary bin: multiply the volume of one primary bin (line 4) by 0.661	10.6 m3 x **0.67** = 7.17 m^3	_____ x **0.67** = _____ m^3
6. Calculate the nunmber of units: divide the volume of one primary bin (line 4) by the proposed pile height (1.4 - 1.8 m or 4 - 6 ft.) and divide by a maximum floor area of 6 m^2 (64 $ft.^2$) per bin. (Note: floor area may be greater if bins are no more than 2.45 m (8 ft.) wide.)	10.7 m^3 ÷ 1.8 m ÷ 6 m2 = **0.99**	_____ m^3 ÷ _____ ÷ m2 = _____

C. Determine the approximate volume of a storage bin needed for an annual supply of substrate.

[1] The volume of the secondary bin should be at least 2/3 the volume of one primary bin.

6. Calculate the approximate volume of substrate storage bin: multiply the volume of one priamry bin (line 4) by 2^2.	10.7 m^3 x **2** = 21.4 m^3	_____ x **2** = _____ m^3

[2] Generally, the volume of substrate required for one year of composting will equal the combined volume of the primary bins.

A larger bin may be necessary if a very coarse and low density substrate is used.

"**Purple**" colour indicates a standard number used in calculation.

Table 3: Conversion Factors for Some Common Substrates

Substrate	Conversion Factor (kg/m^3 year)	
	Mortalities Under 25 kg (55 lb)	Mortalities 25 kg (55 lb.) and over
Sawdust	1406	703
Straw	730	365
Corn Stalks	595	297
Corn Cobs	1784	892
Corn Silage	2677	1338

The conversion factor is calculated as follows:

Density is specific to the substrate used.
See Table 4 below.

Conversion Factor = (365 days/year) Days for first heat stage (45 days **OR** 90 days)

Number of days will depend on average weight of mortalities.

= Density of substrate (kg/m^3) ÷ 1.5

This number creates an allowance to ensure space for expansion or unexpected mortalities.

e.g. (365 days/year ÷ 90 days) x (260 kg/m^3 ÷ 1.5) = 703 kg ÷ m3 year

Table 4: Density of Some Common Substrates

Substrate	Density (kg/m^3)
Sawdust	260
Straw	135
Corn Stalks	110
Corn Cobs	330
Corn Silage	495

Estimated Average Mortality Rates and Weight of Various Animals

Type of Livestock or Poultry	Average Mortality Rate	Average Weight	
	(% / Year)	(lb.)	(kg)
Cattle and Horses			
Birth	9	100	45
Weanling	1.5	600	273
Yearling	1.5	900	409
Mature	2.5	1400	636

Sheep and Goats			
Stillborn	5.5	8	4
Lambs - 1st 10 days	7	9	4
Lambs Pre-weaning	2	45	20
Total Lamb Mortality	16.4	20.7	9
Adult Flock	4.5	170	77
Swine			
SEW Sows	5.5	440	200
Preweaners	19	4	2
SEW Weaners	2.6	29	13
Growers	1.7	99	45
Finishers	2.5	194	88
Poultry			
Broiler - Pullets	2.5	3.5 - 5.5	1.7 - 2.5
Broiler - Cockerel	3.5	5.5 - 7.7	2.5 - 3.5
Layers	8	4.5	2
Breeding hens	14.5	7.5	3
Turkey - Breeders	5 - 7	25.3 - 26.4	11.5 - 12
Turkey - Toms	7 - 11	30.8	14
Turkey - Hens	4 -6	16.5	7.5
Bison			
Calf (2 - 6 months)	2.2	100 - 220	45 - 100
Weaned Calves	1.7	400 - 440	180 - 200
Adult Cows	0.8	825	375
Adult Bulls	1.7	1760	800
Elk			
Birth		35 - 44	16 - 20
Weaning		290	130
Yearling	2 - 3	350	160
Adult Cows		620	280
Adult Bulls		770	350
Red Deer			
Calf (Birth)		18 - 22	8 - 10
Weaning		110	50
Yearling	2 - 3	143	65
Adult Hinds		220	100
Adult Stags		330	150
White Tail Deer			
Calf (Birth)		9	4
Yearling	2 - 3	143	65
Adult Bucks		220	100
Adult Does	5%	155	70
Fallow Deer			
Calf (Birth)		9	4

Yearling	2 - 3	110	50
Adult Does		155	70
Adult Bucks		275	125
Mink			
Adult Male		6	3
Adult Females	4.5 % loss prior to pelting	3.3	2
Mink Kit at Pelting		4.1	2
Carcasses after pelting		3.08	1
Foxes			
Adult Males		22.5	10
Adult Females		17.5	8
Male Pups (at pelting)		15	7
Female Pups (at pelting)		13	6
Carcasses after pelting		11	5

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Appendix 2: Composting Record Sheet

(use one sheet per bin)

Bin Type (Primary, Secondary)	Bin # (1,2,3...etc)	Date Initiated	Comments:

- Temperatures must reach 55°C (131°F) and remain between 55°C (131°F) and 65°C (149°F) during both heating cycles
- Moisture levels will range between 40 and 60 per cent
- Substrate cover must remain at 0.6 m (2 ft.)

If measured values are outside of expected ranges, refer to troubleshooting guide for possible solutions.

Date	Temperature	Moisture Level	Mortalities Added (species and weight)	Substrate (amount & type)	Observations /Comments
Example	62°C	45%	1 calf, 45 kg	Sawdust, ~70 kg	

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Appendix 3: Troubleshooting Guide

Problem	Cause	Possible Solution
Improper Temperature		
1. Too cold	1. Too wet	1a. Remove pile contents and add substrate. 1b. Protect pile from weather or shape to shed water.
	2. Low C:N ratio	2. Evaluate amount and type of substrate and adjust as necessary.
	3. Too porous	3. Replace or mix existing substrate with sawdust or another small-particle substrate.
	4. Insufficient substrate cover	4. Add substrate to top of pile.
2. Too hot	1. Too dry	1. Add water to mortality area.
Failure to Decompose		
Failure to Decompose	1. Low carbon	1. Evaluate amunt and type of substrate and adjust as necessary.
	2. Mortalities layers too closely	2. Adjust pile ensure 0.2 m to 0.3 m (8 to 12 in.) of substrate between layers.
	3. Mortalities placed too closely together	3. Adjust mortalities ensuring they do not touch each other.
	4. Mortalities placed too close to the side of the bin.	4. Adjust pile ensuring mortalities are placed ad least 0.3 (1 ft.) from the bin wall.
Odour		
1. Foul, high sulfur, organic acids	1. Too wet	1a Remove pile contents and add substrate. 1b Protect pile from weather or shape ot shed water.
	2. Not enough cover substrate	2. Add substrate ensuring 0.6 m (2 ft) of cover.
	3. Air flow restricted	3a. Evaluate amount and type of substrate and adjust as necessary 3b. Replace or mix existing substrate with a larger particle substrate. 3c. Adjust pile ensuring mortalities are placed at least 0.4 m (1 ft.) from edge of side of the bin.
	4. Excessive custing on surface	4. Break up crusting on the surface and avoid using substrate that is frozen or too wet.
2. Smell of decaying flesh	1. Not enough cover substrate	1. Add substrate ensuring 0.6 m (2 ft.) of cover.

	2. Too cold	2. Follow steps outlined above under "improper temperature".
3. Ammonia	1. Low carbon	1. Evaluate amount and type of substrate and adjust as necessary.
Flies		
Flies	1. Not enough cover substrate	1. Add substrate ensureing 0.6 m (2 ft.) of cover
	2. Poor sanitary conditions	2a. Remove leachate from around pile. 2b. Maintain a clean, debris free area around compost site.
	3. Too cold	3. Follow steps outlined above "improper temperature"
	4. Too hot	4. Add water to mortality area.
Animals / Vermin		
Animals / Vermin	1. Inadequate protection	1a. Add substrate ensureing 0.6 m (2 ft.) of cover. 1b. Construct a fence around the site. 1c. Enclose bin structure.

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